REMARKS

Claims 1-41 are pending in this application. By this Amendment, Fig. 16 is amended. Claims 1, 26, 36-39 and 41 are amended.

Reconsideration in light of the foregoing claim amendments and the following remarks is respectfully requested.

I. Fig. 16 is Resubmitted

The Office Action objects to the drawings, asserting that the correction to Fig. 16 filed on March 10, 2003 is not acceptable.

Fig. 16 is resubmitted herein in the form of Replacement Sheet, as the Examiner requested. Fig. 16 was corrected so that step S2570 returns to step S2520 under the condition of "yes," as described in the specification at the last sentence of paragraph 0125.

In view of the above, withdrawal of the objection to the drawings is respectfully requested.

II. Response to Objection to the Claims

The Office Action objects to the claims for informalities. In the originally filed claims, claim 3 did not start a new paragraph. In particular, claim 3 continued on the same line on which claim 2 ended, without starting a new line.

Claim 3 is now set to start a new line below the line in which claim 2 ends. Accordingly, withdrawal of the objection to claim 3 is respectfully requested.

However, Applicant respectfully traverses the objection to the limitation "the pseudo-image" in line 15 of claim 1. The term "pseudo-image is a commonly used term in the field of image processing, and generally means a synthetic digital image that is created by pre- or post-processing of "raw" or conventional digital image data. The term "pseudo-image" is disclosed and discussed in the specification at, for example, paragraphs 22, 35, 57, 59 and 63-67, and Fig. 5.

The Office Action asserts that the limitation "pseudo-image" in line 15 of claim 1 is grammatically incorrect. However, there is no grammatical error in reciting the limitation "pseudo-image."

Nonetheless, claim 1 is amended to recite "generating a pseudo-image that includes a boundary corresponding to a boundary to be located on the object," and for better clarity. Accordingly, withdrawal of the objection to claim 1 is respectfully requested.

III. Response to Rejection of Claims 36 and 41

The Office Action rejects claims 36 and 41 under 35 U.S.C. §112, first paragraph, asserting that the specification does not reasonably provide enablement for detecting the edges based on first and second modes using image texture characteristic and characteristics other than image texture. This rejection is respectfully traversed.

Regarding detecting edges "based on first and second modes", the specification discloses at, for example, paragraph 2, that "many conventional machine visions systems used in locating the edges of features in images are based primarily or exclusively on applying gradient operations to the intensity values of the original image pixels." Thus, the specification supports and enables detecting an edge based on characteristics other than image texture, and a first mode for detecting edges. A second mode for detecting edges is disclosed for detecting edges based on a texture characteristic, and enablement is provided throughout the specification. For example, paragraphs 77-79 of the specification provide a plurality of alternatives that may be used for determining whether a first or second mode of edge detection is appropriate.

For at least the above reasons, withdrawal of the rejection of claims 36 and 41 under 35 U.S.C. §112, first paragraph, is respectfully requested.

IV. Response to Rejection of Claims 32-35

The Office Action rejects claims 32-35 under 35 U.S.C. §112, first paragraph, asserting that the specification does not reasonably provide enablement for determining the boundary location with "a resolution better than 5, 25 and 100 microns" on the object imaged by the machine vision system, and "with a sub-pixel resolution" relative to the image of the object imaged by the machine vision system. This rejection is respectfully traversed.

Regarding enablement for "with a sub-pixel resolution," the specification discloses at, for example, paragraph 70, "the edge point detection circuit or routine 378 estimates an edge point along each scan line ... The values along each scan line in the pseudo-image constitute a one-dimensional signal. In one exemplary embodiment the edge point is a point of maximum gradient along the scan line signal in the pseudo-image." As is known in the art, the point of maximum gradient, being a property of the continuous one-dimensional signal curve defined by values along each scan line, is typically estimated to fall between the pixel value locations that define the one-dimensional signal. Since the maximum gradient is not restricted to fall *at* the pixel locations, but may typically fall *between* the pixel locations, it is obvious that the technique outlined above will locate an edge point *with sub-pixel resolution*.

Furthermore, beginning at paragraph 72, the specification provides: "The edge point refining circuit or routine 379 may then perform operations to refine one or more initial edge point estimates, based on additional information." Since the initial edge point estimates may have a subpixel resolution, as outlined above, it follows that a refining circuit would also provide an even better or more reliable subpixel resolution. Taken in its entirety, paragraph 72 describes a method for analyzing a few ("q") pixels around an "initially estimated edge point" to refine an edge location. The method provides calculated Euclidian "distance" values located at each of the q pixel locations to form a curve. The analysis operation then determines a centroid location for the area under the curve. The centroid location is in terms

of the pixel locations, and thus determines the refined edge point estimate along the scan line. As is known in the art, a centroid calculation is a type of "weighted average" calculation. Because it calculates an "average", it may generally return a value that falls between the weighted sample locations that are used to determine the centroid. Since, in the method outlined in paragraph 72, the weighted sample locations are at a "pixel resolution", *it follows that the centroid will typically be determined with a subpixel resolution*, at some point between the pixel locations.

Furthermore, the specification provides enablement for the specific number microns recited in the claims for the following reasons. First, the specific number microns are recited in the originally filed claims, which are a part of the specification. Thus, the specific number microns are supported in the original specification. Second, as discussed above, the specification enables subpixel resolution. Third, in paragraph 10 of the specification, it is apparent that an object of the disclosure is "for finding relatively precise positions for edge locations at the boundaries between regions". Thus, precision is an object of the disclosure, and according to the previous discussion it is obvious that the scope of "precision" may extend to the pixel and sub-pixel level. Fourth, it is known in the art that a typical pixel pitch of a camera used by a machine vision system is on the order of 10 microns. Finally, as stated in paragraph 87 of the specification, the pseudo-image 700 is magnified. Therefore, a 10 micron camera pixel pitch would correspond to a magnified distance of *less* than 10 microns *on the actual object that is imaged.*

For any or all of the above reasons, this specification provides enablement for determining a boundary location with a resolution better than 5, 25 and 100 microns, and for "a sub-pixel resolution." Accordingly, withdrawal of the rejection of claims 32-35 under 35 U.S.C. §112, first paragraph, is respectfully requested.

V. Response to Rejection of Claims 1-39 and 41

The Office Action rejects claims 1, 26, 36 and 41 under 35 U.S.C. §112, second paragraph, asserting that the limitation "the boundary location usable as a dimensional inspection measurement for the object imaged by the machine vision system" is unclear. The Office Action also rejects claims 2-25, 27-35 and 37-39 under 35 U.S.C. §112, second paragraph, for the same reason.

Claims 1, 26, 36 and 41 are amended to delete the allegedly unclear limitation without prejudice or disclaimer. Accordingly, withdrawal of the rejection of claims 1, 26, 36 and 41, and claims 2-25, 27-35 and 37-39 depending therefrom, under 35 U.S.C. §112, second paragraph, is respectfully requested.

VI. Response to Rejection of Claim 26

The Office Action rejects claim 26 under 35 U.S.C. §112, second paragraph, asserting that the limitation "generating a pseudo-image ... based on at least one image texture filtering element pre-selected based on an analysis of previous similar-case boundary" is unclear. This rejection is respectfully traversed.

The specification provides clear explanation of the above-quoted limitation at, for example, paragraphs 0089 and 0120. In at least one example, the above-quoted limitation may refer to using a boundary tool that has been previously "trained" on a specific boundary in an input image (that is, "a previous similar-case boundary"), to later generate and analyze a pseudo-image for a similar image (e.g., on a duplicate of the object used for the original "tool training".) As stated in paragraph 120, "accordingly, the edge detection systems and methods of this invention can now be used in an automated mode to locate edges or boundaries in *a different but similar case* of that input image during a run mode."

Also, as discussed in paragraph 89, "the case-specific routine or trained edge/boundary detection tool stored by the control system portion 100 is generally stored

and/or included in one more part programs, and are usable to automatically, quickly and reliably detect and locate edges in similar cases in a "run mode". The similar cases where the case-specific routine and/or trained edge/boundary tool may be advantageously usable include, for example, cases such as locating the identical edge in the future, locating another portion of the same edge on the same part, i.e., in a different field of view, locating the "same" edge on a future part produced according to the same specifications, and locating other edges made by the same process, such as edges on a variety of similar holes in various locations on a flat sheet, such as printed circuit board holes. These and other type of similar-edge cases will be apparent to those skilled in the art and to typical users of machine vision systems and accordingly these examples are in no way limiting."

In addition, as discussed in paragraph 91, "Fig. 7 is a flowchart outlining one exemplary embodiment of a method for training a boundary detection tool to detect a specific case of an edge in an input image according to this invention. A trained boundary detection tool can be usable by a fast and reliable automatic boundary detection routine, such as may be included in a part program for inspecting similar cases of edges on similar parts."

Procedures for training the boundary detection tool, referred to above, are fully discussed in the specification. One exemplary procedure is fully outlined with reference to Figs. 7-14, which describe at least one exemplary way of selecting ("pre-selecting") texture filters to make a texture filtering element that is effective for generating an advantageous pseudo-image of a boundary that used while training the boundary tool. One skilled in the art understands that a boundary tool is trained on an image feature that is characterized as the "previously similar-case boundary" in claim 26, that the "pre-selected texture filtering element" referred to in claim 26 may be the set of filters determined while training the boundary tool according to the teachings related to Figs. 7-14 or the like, and that a pseudo-

image can be generated based on the pre-selected texture filtering elements as described generally throughout the specification, and recited in claim 26.

Accordingly, the meaning of the terms used in claim 26 are clear in light of the teachings and related terms used in the specification. Withdrawal of the rejection of claim 26 under 35 U.S.C. §112, second paragraph, is respectfully requested.

VII. Response to Rejection of Claim 40

The Office Action rejects claim 40 under 35 U.S.C. §112, second paragraph, asserting that the limitation "a boundary locating and refining section that analyzes the one or more estimated edge points to determine if they correspond to criteria for a reliable edge" is unclear. This rejection is respectfully traversed.

The specification provides clear explanation of the above-quoted limitation. One example of a boundary locating and refining section is the boundary locating and refining circuit or routine 380 and related operations described at paragraphs 36, 38, and in particular in paragraphs 73, and 75-76. Accordingly, the meaning of the cited terms used in claim 40 are clear in light of the teachings and related terms used in the specification.

The Office Action appears to be artificially requesting that the locating and refining be performed either simultaneously or separately. Such an artificial restriction is improper. "Boundary locating and refining section" is just a descriptive name for the apparatus element, and does not imply that any associated operations are sequential, simultaneous, or even distinguishable from one another.

For at least the above reasons, withdrawal of the rejection of claim 40 under 35 U.S.C. §112, second paragraph, is respectfully requested.

VIII. Response to Rejection of Claims 37-39

The Office Action rejects claims 37-39 under 35 U.S.C. §112, second paragraph. Claims 37-39 are amended to correct their dependence. Accordingly, withdrawal of the

rejection of claims 37-39 under 35 U.S.C. §112, second paragraph, is respectfully requested.

IX. Conclusion

In view of the foregoing, it is respectfully submitted that this application is in condition for allowance. Favorable reconsideration and prompt allowance of claims 1-41 are earnestly solicited.

Should the Examiner believe that anything further would be desirable in order to place this application in even better condition for allowance, the Examiner is invited to contact the undersigned at the telephone number set forth below.

Respectfully submitted,

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TJP:GXL/axl

Attachments:
Replacement Sheet
Petition for Extension of Time

Date: July 1, 2005

OLIFF & BERRIDGE, PLC
P.O. Box 19928
Alexandria, Virginia 22320
Telephone: (703) 836-6400

DEPOSIT ACCOUNT USE AUTHORIZATION
Please grant any extension necessary for entry;
Charge any fee due to our Deposit Account No. 15-0461

Amendments to the Drawings:

The attached replacement drawing sheet makes changes to Fig. 16 and replaces the original sheet with Fig. 16.

Attachment: Replacement Sheet